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Two Smithsonian organizations, the Monitoring and Assessment of Biodiversity Program (SI/MAB) and the Center for Tropical Forest Science (CTFS), continue ongoing research projects in Western and Central Africa. SI/MAB conducted a one-day stakeholders meeting to develop an integrated approach to environmental resource management, broad stakeholder participation, and coordinated action in biological assessment. In addition, as a follow-up to last year's training course, biological monitoring continues at the Takamenda Forest Reserve. For the Center for Tropical Forest Science (CTFS), previous funding led to the development of 50-ha CTFS Korup Forest Dynamics Plot (KFDP). This research plots seeks to better understand forest dynamics and tropical forest ecosystems through analysis of forest biology, spatial distribution, and species identification. Current research efforts in the Korup Forest Dynamics Plot focus on data management and map digitization, as well as complementary research projects on seedling demography, phenology, and the enumeration of lianas. In July, KFDP scientists participated in the first of five analytical workshops coordinated by the Center for Tropical Forest Science. The analytical skills obtained from these workshops aim to foment data analysis and promote scholarly publications from the Korup plot.

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## TABLE OF CONTENTS

<b>I.</b>	<b>Front Cover</b>	<b>1</b>
<b>II.</b>	<b>SF 298</b>	<b>2</b>
<b>III.</b>	<b>Foreword</b>	<b>3</b>
<b>IV.</b>	<b>Table of Contents</b>	<b>4</b>
<b>V.</b>	<b>Introduction</b>	<b>5</b>
<b>V.</b>	<b>Project Activities</b>	
	<b>A. SI/MAB Biodiversity and Monitoring</b>	<b>5</b>
	<b>1. SI/MAB Stakeholder Meeting Workshop</b>	<b>5</b>
	<b>2. SI/MAB Biodiversity Assessment of the Takamanda Forest Reserve, Cameroon</b>	<b>6</b>
	<b>B. Large-Scale CTFS Korup Forest Dynamics Plot</b>	<b>8</b>
	<b>1. CTFS 50-ha Korup Forest Dynamics Plot</b>	<b>9</b>
	<b>a. Data Management</b>	<b>9</b>
	<b>b. Field Checking</b>	<b>9</b>
	<b>c. Enumeration of Lianas</b>	<b>9</b>
	<b>d. Phenology</b>	<b>10</b>
	<b>e. Map Digitizing</b>	<b>11</b>
	<b>2. Training and Outreach</b>	<b>11</b>
	<b>a. CTFS Analytical Workshop</b>	<b>11</b>
<b>VI.</b>	<b>Research and Training Accomplishments</b>	<b>11</b>
<b>VII.</b>	<b>Reportable Outcomes</b>	<b>11</b>
<b>VIII.</b>	<b>Conclusions</b>	<b>12</b>

## **V. Introduction**

The AP1 program of the Drug Development and Conservation of Biodiversity in West and Central Africa funds the studies on forest dynamics and demographics conducted by two Smithsonian organizations, the Monitoring and Assessing Biodiversity Program (SI/MAB) and the Center for Tropical Forest Science (CTFS). SI/MAB conducted a one-day stakeholders meeting on the crucial aspects of biodiversity monitoring, assessment and inventory. This meeting aimed to develop an integrated approach to environmental resource management, broad stakeholder participation, and coordinated action in biodiversity assessment and monitoring. In addition, as a follow-up to last year's biological assessment training course, biological monitoring continues at the Takamenda Forest Reserve.

The Center for Tropical Forest Science has completed a 50-ha Forest Dynamic Plot (FDP) in an effort to study forest plant diversity and dynamics across large spatial and temporal scales. The Korup Forest Dynamics Plot (KFDP) is one in CTFS's network of eighteen FDPs which utilizes an identical methodology throughout all sites in the tropics of Asia, Latin America, and Africa. Within the 50-ha plot, all trees over 1 cm diameter have been tagged and identified to species. Data gathered from repeated censuses allow explorations into the maintenance of diversity and dynamics of the forest. Technicians at the Korup Forest Dynamics Plot continue to collect and verify data within the plot. The enumeration of lianas will augment the species inventory as long term projects proceed in KFDP which complement the study of forest dynamics in KFDP. Korup Forest Dynamics Plot project leaders attended the inaugural workshop of the Center for Tropical Forest Science Analytical Workshop Series. Held in Bangalore, India, this workshop was the first of five coordinated by the international network of Forest Dynamics Plots. The purpose of these workshops is to promote the exchange of analytical skill to manage and manipulate the large datasets at each of the sites.

## **VI. Project Activities**

### **A. SI/MAB Biodiversity Assessment and Monitoring**

#### **1. SI/MAB Stakeholder Meeting Workshop**

Local implementation of the objectives of the Convention on Biological Diversity in Nigeria, including the crucial aspects of biodiversity monitoring, assessment and inventory (Article 15) has been constrained by the absence of an integrated approach to environmental resource management, broad stakeholder participation, and a lack of coordinated action. It is against this background that SI/MAB and BDCP organized a one-day stakeholder policy workshop on April 18<sup>th</sup>, 2001, at the Bioresources Development Centre (BioDEC), Abuja, Nigeria. This was the first of a three-phased project that will now be followed by a training course and field assessments. It was organized in collaboration with local partners, including the Federal Ministry of Science and Technology (FMST), the Federal Ministry of Environment (FME) and the National Parks Service (NPS).

The meeting was very successful with a total of 27 participants in attendance from twenty states and four federal government ministries. The participants were comprised entirely of directors of policy-making departments and agencies. This profile significantly enhanced the quality of the discussions and the output of the meeting.

The meeting deliberated on framework strategies for conducting a national multi-taxa biodiversity monitoring program and for integrating this into national programs. By bringing together policy makers from the federal and state government levels, as well as the non-governmental organizations and activating dialogue with the stakeholders, it has successfully laid the foundation for the biodiversity assessment and monitoring course, as well as the follow-up field assessments in the Okwangwo-Gashaka Gumti region. Furthermore, the participants gained a stronger understanding as to the conceptual framework involved for the initiation of a biodiversity assessment and monitoring program.

Results from this workshop have already fed into the follow-up phases of the project and will continue to do so as well as enhance its participatory base. In this regard, separate meetings were held on the 19<sup>th</sup> of April with officials from FME and NPS to deliberate on the logistics for the course and the follow-up field assessment and the feasibility of the transborder natural resource management concept.

## **2. SI/MAB Biodiversity Assessment of the Takamanda Forest Reserve, Cameroon**

SI/MAB conducted a training course on Assessment and Monitoring techniques in Cameroon. This course and the planned follow-up activities aim to achieve the objectives outlined by AP1 for the West Africa ICBG, including, 1) detailed assessments of the biodiversity of West-Central African forests; 2) assessment of the dynamics of these forests and of factors maintaining the biodiversity; and 3) providing intensive training in plant taxonomy, collection techniques, biodiversity inventory and monitoring, data analysis, environmental management and leadership for local students and natural resource technicians.

The Takamanda Forest Reserve covers about 700 km<sup>2</sup>, located in the northernmost point of Cameroon's South-West Province, north of the extensive Cross River Valley. The Reserve stretches along the eastern border of Nigeria, and forms a contiguous protected area with the Okwangwo portion of the Cross River National Park. Approximately 20% of the reserve can be considered highland, or sub-montane forest. The majority of these highlands are found in the north of the Reserve with additional highland areas, up to 720m, found in the east (between Kekpane and Basho) and west (along the border with Nigeria) of the reserve.

Most of the southern and central portion of the reserve is covered by dense lowland humid Guineo-Congolian forest. Dense sub-montane forest is found in the northern part of the reserve. In the extreme northern region are isolated patches of wooded savanna and gallery forest. Local communities (Anyan) in the region use a variety of non-timber forest

products including bush mango (*Irvingia gabonensis*), bush pepper (*Piper guineensis*), and *Prunus africana*.

Initial surveys in the Reserve conducted by WWF have highlighted the biological importance of the area, and the need for assessments that will help determine the conservation priorities for the region. Meetings with several organizations revealed the possibility of establishing a multi-disciplinary team of experts with a common interest in the region to conduct such an assessment. Such a series of assessments have been conducted.

### **Vegetation Assessment**

Biodiversity plots (10 x 1 ha) and Modified Whittaker plots (36 x 0.1 ha) have been established in Takamanda Forest Reserve. They will provide information on spatial variability in forest structure and composition at each of the sites. This information is the first quantitative vegetation assessments for the forest reserve, and will provide comparable data to that collected in nearby Ejagham Forest Reserve, and enable comparisons with the KFDP (ICBG 1b). The plots have been established along an altitudinal gradient:

- **Lowland *terra firme* forest:** 8km from Takamanda village (06°01'N:09°16'E); establishment of 2 x 1ha PSP's and 8 x 0.01ha Whitaker plots;
- **Lowland *terra firme* forest:** 9km from Obonyi 3 along Matene path (06°11'N:09°20'E); establishment of 2 x 1ha PSP's and 8 x 0.01ha Whitaker plots;
  - **Riverine forest:** 5km from Obonyi 1 (06°07'N:09°15'E); establishment of 2 x 1ha PSP's and 8 x 0.01ha Whitaker plots;
  - **Ridge forest:** 10km from Kekpani in the Basho hills (06°05'N:09.23'N) establishment of 2 x 1ha PSP's and 8 x 0.01ha Whitaker plots;
  - **Mid-elevation forest:** 6km from along the Matene to Mende path (06°16'N:09°21'E); establishment of 1 x 1ha PSP and 4 x 0.01ha Whitaker plots;
  - **Montane (or gallery) forest:** 1km from Mende in the forest / savannah interface (06°19'N:09°22'E); establishment of 1 x 1ha PSP and 4 x 0.01ha Whitaker plots;

Qualitative assessments of the vegetation have been conducted along the area. These are in the form of random collection of fertile herbarium specimens throughout the study period. This is facilitating the training of local "para-taxonomists" in basic plant collection techniques, as well as on-going collection by in-country professional botanists, including those from the Limbe Botanic Garden. This will lead to, not only a quantitative analysis of the vegetation, but will also enable a qualitative assessment of the floristic richness and potential endemism of the area. Both means of data collection enable a basic floristic checklist to be produced.



### **Additional Assessments**

Using the model developed in the Lower Urubamba Region, Peru, SI/MAB has seen an ideal opportunity to facilitate the assessment of baseline information on other taxonomic groups within the Takamanda FR. In collaboration with other organizations the following studies have also been conducted:

#### **Large mammals, with a particular emphasis on the gorilla population (WWF and WCS)**

An isolated population of gorillas has been known to occur in the Takamanda Forest Reserve and the adjacent Okwangwo forests of eastern Nigeria since the early 1900's. Recent research, including mitochondrial DNA analysis of hair samples suggests that these gorillas are more taxonomically distinct than previously described and they are now termed the Cross River Gorillas. Recent work indicates that the gorilla population limits itself almost entirely to the highland areas of the Reserve. Recent surveys are adding valuable information on these populations.

#### **Birds (Birdlife International and Cameroon Ornithology Club)**

The TFR has been identified as an Important Bird Area (IBA) by the Birdlife Cameroon Programme, primarily due to a substantial lack of knowledge of the avifauna of the region. A team of ornithologists from the partner NGO, Cameroon Ornithology Club (COC) has undertaken bird surveys in target areas in the Reserve using point counts, call identification and mist netting. COC and Birdlife International are providing support for this activity. To date they have completed surveys in Mende, Matene, Kekpane/Basho and Obonyi I. Approximately 280 species (including a new record for Cameroon) were recorded. Additional surveys are planned for the end of the year.

#### **Dragonflies (WWF)**

Preliminary surveys undertaken by WWF have highlighted the endemism and diversity of these taxa. Indeed a new genus of dragonfly from the Takamanda area has been recently described. Utilizing the survey skills of local para-taxonomists, specimens will continue to be sent to the dragonfly specialist in the UK for identification, analysis and reporting.

#### **Reptiles and amphibians**

A significant number of herpetological samples were collected recently in the region through a WWF funded project. Analysis and dissemination of these data is pending. Further sampling, again with the use of local collectors, will focus on areas not yet surveyed.

### **B. Large-scale CTFS Korup Forest Dynamics Plot**

#### **1. CTFS 50-ha Korup Forest Dynamics Plot**

The enumeration of the 50-ha Korup Forest Dynamics Plot (KFDP) was initiated in January 1997 and completed in July 1999, following the standardized methodology of the Center for Tropical Forest Science (CTFS) network of long-term biological and socio-economic research



plots in tropical forests in Asia, Africa, and Latin America. The 50-ha plot was divided into 1250 quadrats of 20x20 m. and all free standing plants with dbh>1cm were mapped and identified to study forest dynamics and long-term research questions relating to distribution, density, and diversity in tropical forests. Within the plot, there were 329,147 total stems of dbh >1 cm and a mean of 6583 stems/ha. Sixty-one families and 482 species were represented in this Forest Dynamics Plot. Though the initial enumeration has been completed, there are many responsibilities in the field and the laboratory to verify and correct the original data collected. Additionally, numerous complementary studies of forest biology and dynamics have continued in the plot.

#### **a. Data Management**

Data management currently is one of the great foci of the Korup Forest Dynamics Plot Program. The enormous amount of information collected from the enumeration of woody stems from the 50-ha plot must be appropriately stored and managed. Data entry teams continue to clean the data and laboriously double-enter all field measurements into the main database. Additional verification is done through field checking to ensure accuracy. Thus far, 46 hectares have been completed

Data entry efforts were supplemented by the use of a laptop computer made available from Dr. George Chuyong. The Center for Tropical Forest Science purchased a new IBM thinkpad laptop for the KFDP and Dr. Chuyong and David Kenfack will share this powerful computer for data analysis.

#### **b. Field Checking**

Technicians continue to verify the data obtained from the first census by returning to the field to check mistakes generated from the data entry process. Field teams have checked hundred of trees this past year and continue to update the data files that are being stored in FoxPro. Field visits have found trees in the plot to be dead, down, or untagged. This field checking provides invaluable information which maintains the desired accuracy of the database between censuses.

#### **c. Enumeration of Lianas**

Innocent Buama Leingola of the Ituri Forest Large Plot Project in the Democratic Republic of Congo visited KFDP from 16-22 May in 1998 and trained the field staff in liana enumeration.

The enumeration of lianas continued this past year to reach a total of five completed hectares. Though many individuals remain currently unidentified, 203 species/morphospecies, in at least 26 families and 57 genera, have been catalogued (Table 1).

The identification of the remaining unknown individuals will likely increase the overall taxonomic diversity of lianas in the plot. Present and future identification of lianas is

aided by the collection of voucher specimens. During this past year, greater than fifty-two fertile materials were collected in two to six duplicates and will be housed in herbaria in Cameroon and internationally.

Table 1: Diversity of lianas in the sampled 5 hectares in the 50-hectare Korup Forest Dynamics Plot

Family	# OF GENUS	# OF SPECIES
Anacardiaceae	2	2
Ancistrocladiaceae	1	1
Annonaceae	5	12
Apocynaceae	8	21
Araliaceae	1	1
Arecaceae	2	4
Aristolochiaceae	1	2
Celastraceae	1	13
Combretaceae	1	1
Connaraceae	4	16
Convolvulaceae	1	2
Curcubitaceae	2	2
Dichapetalaceae	1	19
Dilleniaceae	1	1
Euphorbiaceae	1	1
Fab/ papilionaceae	6	11
Icaciniaceae	2	2
Linaceae	1	2
Loganiaceae	1	8
Moraceae	1	5
Passifloraceae	2	2
Polygalaceae	1	1
Rubiaceae	8	46
Rutaceae	1	2
Tiliaceae	1	1
Vitaceae	1	3
Unknown		22
Totals	57	203

#### d. Phenology

Dr. Chuyong initiated a study on the phenology of the nine most common species in the 50-ha plot. He continues to examine six canopy species (*Oubanguia alata*, *Klaneanthus gabonae*, *Dichostemma glaucenscens*, *Strombosia pustulata*, *Garcinia conrauana*, *Hymenstegia afzelii*) and three understory species (*Phyllobotrum spatula*, *Cola sermacarpophylla*, *Cola attiensis*). *Garcinia couraouna* (Clusiaceae), a common canopy species with in the Korup Forest Dynamics Plot, is of special interest in this study as it is valued for the medicinal properties of its latex, bark, and seeds. As prescribed in the sampling protocol, during the last field season, every fortnight, Dr. Chuyong observed twenty individuals of each species, looking for the following occurrences: flowering, fruiting, leaf flush, and leaf fall. Dr. Chuyong and field workers at the plot have

continued this project over the past two years. Phenological field teams are sent periodically to maintain this project. An understanding of the developmental requirements of *Garcinia couraoua* is a useful tool for guiding the management and conservation of the species within the Korup area.

#### **e. Map Digitizing**

Data entry teams have also continued digitizing maps for the individual quadrats of the plot. Twenty hectares have been digitized.

### **3. Training and Outreach**

#### **a. Center for Tropical Forest Science Analytical Workshop**

Korup Forest Dynamics Plot scientists, David Kenfack, George Chuyong, and Duncan Thomas participated in a three and a half week long training course in July 2001. The training course was the first in a series of five workshops covering basic analytical techniques coordinated by the Center for Tropical Forest Science. Hosted by the Indian Institute of Science in Bangalore, India, the analytical workshop convened over 30 scientists and data managers from the Center for Tropical Forest Science's network of 14 Forest Dynamics Plots located throughout the tropics. Entitled, "Spatial Patterns and Habitat Associations in Tropical Forests," the analytical workshop aimed to teach participants basic analytical techniques for manipulating extremely large datasets. Because the methodology of all CTFS Forest Dynamics Plots is identical, powerful tools for managing and maintaining the plots' databases were developed and disseminated to each of the sites. With these skills, KFDP scientists will be able to perform complex calculations on plot datasets to analyze patterns habitat association and better understand diversity in this tropical forest. In addition, these workshops will promote the collaboration and the intellectual exchange among network scientists. In addition, the techniques obtained from these workshops aim to foment data analysis and promote scholarly publications at the individual plot level.

### **VI. Research and Training Accomplishments**

- Completion of enumeration and survey of 50-ha Forest Dynamics Plot
- Continuation of projects complementary to the Korup Forest Dynamics Plot focusing on the phenology of *Garcinia conrauna*, and liana enumeration
- Participation in the Center for Tropical Forest Science Analytical Workshop Series in Bangalore, India.

### **VII. Reportable Outcomes**

- Database of topography and species composition of 50-ha Korup Forest Dynamics Plot

- Growth of usable database for KFDP species through improved data entry and field checking
- Plot digitization of topographic features available for approximately half of the Korup Forest Dynamics Plot.

## **VIII. Conclusions**

The success of the completed enumeration of the 50-ha Korup Forest Dynamics Plot continues as field teams verify and augment the already extensive database of more than 300,000 species. Complementary projects focusing on phenology and liana enumeration proceed in KFDP, adding valuable information about the diversity and forest dynamics of this tropical forest. Data analysis and verification will aid the current studies on long-term forest trends which will present insights into species abundance, density, and population distribution. Map digitization will promote as well as help answer additional research questions in tropical forest science. In addition, advances in field research continues as botanical sampling in medicinal research provides a practical application to the research activities at the KFDP. Scientists from the Korup Forest Dynamics Plot, over the next four years, will be active participants in the Analytical Workshop Series coordinated by the Center for Tropical Science for its network of demographic tree plots. The training gleaned from these workshops will be an invaluable asset to the data analysis and management currently employed at the site. Overall, the research and training activities at Korup have moved beyond the foundation of great basic research and are on the verge of transitioning into the phase where great findings are contributed to the greater scientific community.